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A new setup for studying thermal microcracking through acoustic emission monitoring

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Thermal stressing is common in geothermal environments and has been shown in the laboratory to induce changes in the physical and mechanical properties of rocks. These changes are generally considered to be a consequence of the generation of thermal microcracks and debilitating chemical reactions. Thermal microcracks form as a result of the build-up of internal stresses due to: (1) the thermal expansion mismatch between the different phases present in the material, (2) thermal expansion anisotropy within individual minerals, and (3) thermal gradients. The generation of cracks during thermal stressing has been monitored in previous studies using the output of acoustic emissions (AE), a common proxy for microcrack damage, and through microstructural observations. Here we present a new experimental setup which is optimised to record AE from a rock sample at high temperatures and under a servo-controlled uniaxial stress. The design is such that the AE transducer is embedded in the top of the piston, which acts as a continuous wave guide to the sample. In this way, we simplify the ray path geometry whilst minimising the number of interfaces between the microcrack and the transducer, maximising the quality of the signal. This allows for an in-depth study of waveform attributes such as energy, amplitude, counts and duration. Furthermore, the capability of this device to apply a servo-controlled load on the sample, whilst measuring strain in real time, leads to a spectrum of possible tests combining mechanical and thermal stress. It is also an essential feature to eliminate the build-up of stresses through thermal expansion of the pistons and the sample. We plan a systematic experimental study of the AE of thermally stressed rock during heating and cooling cycles. We present results from pilot tests performed on Darley Dale sandstone and Westerly granite. Understanding the effects of thermal stressing in rock is of particular interest at a geothermal site, where circulating fluids influence the temperature field in the surrounding rock mass. These stresses can, for example, provoke thermal borehole breakouts due to cooling-induced tensile microcracking or may be actively used to enhance the injectivity of geothermal wells.